



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

**Subject: AUTOMATIC PRESSURE
ALTITUDE ENCODING
SYSTEMS AND
TRANSPONDERS:
MAINTENANCE AND
INSPECTION PRACTICES**

Date: xx/xx/xx

AC No: 43-6B

Initiated by: AFS-300

Change:

1. **PURPOSE.** This advisory circular (AC) provides information concerning acceptable methods of testing and installing altitude encoding systems and air traffic control (ATC) transponders.
2. **CANCELLATION.** AC 43-6A, dated November 11, 1977, is canceled.
3. **RELATED MATERIAL.** Title 14, Code of Federal Regulations (14 CFR) §§ 43.3, 43.5, 43.9, 43.13, 65.85, 91.213, 91.215, 91.217, 91.411, and 91.413; AC 43-203B, Altimeter and Static System Tests and Inspections; Technical Standard Order (TSO) C-74c, Airborne ATC Transponder Equipment; TSO C-88a, Automatic Pressure Altitude Reporting Code Generating Equipment.
4. **BACKGROUND.** Service difficulty reports, information reported through the malfunction or defects system, and observation by aviation safety inspectors show a need for expanded and updated guidance for maintenance and inspection of transponder and altitude encoding systems. A significant number of reports from air traffic facilities are related to erroneous altitude reporting. Evaluation of these reports has verified failures or malfunctions of encoding devices that were not evident to the pilot but would have been evident during inspection and/or proper testing of these systems after installation in the aircraft.
5. **INSTALLATION.** Only appropriately rated persons (as specified in § 43.3) may perform an aircraft alteration that consists of installing an encoding altimeter, blind encoder, or transponder system. The approval for return to service of the aircraft may only be accomplished after appropriate testing is performed to ensure that the system performs its intended function(s). When a certificated repair station is used to install an automatic pressure altitude reporting system, or any portion of such a system, the repair station must have an appropriate airframe rating for the installation. Radio and instrument rated repair stations may have limited airframe ratings for the installation of specific makes and models of transponders, digitizers, and encoding altimeters in specific makes and models of aircraft. Alternatively, the repair station may obtain the services of an appropriately rated aviation technician (for example, the

holder of an inspection authorization) to perform the final inspection and approval for return to service of the aircraft after the installation is completed. It is incumbent on the operator to ensure that the repair station has the appropriate rating or personnel to perform the installation and approve the aircraft for return to service. In addition, maintenance personnel must ensure that—

- a. The required test equipment, technical data, and personnel are available to perform, or arrange to have performed, a static system check as required by § 91.411 to verify the integrity of the newly installed or altered system;
- b. The capability is available to determine the actual altitude information transmitted by the transponder as referenced against the pilot's altimeter (altitude reference);
- c. The appropriate repair station rating or an otherwise appropriately rated person to perform any necessary structural modifications is available;
- d. The appropriate authority is available to approve the aircraft for return to service after all maintenance, modification, and testing has been completed; and
- e. The approved data necessary for any substitution(s) of equipment installed that is not shown on the aircraft's approved equipment listing are used.

6. APPROVED DATA ALTERNATIVES.

- a. FAA-approved manufacturer drawings or service bulletins that list approved replacement/substitution encoding altimeters or instructions for the installation of certain digitizers (blind encoders) may be used.
- b. Where no prior approval has been given, a supplemental type certificate or field approval should be requested. The person approving the aircraft for return to service must comply with all provisions of § 43.9.
- c. Field Approvals. In some cases, the facility making the installation meets the qualifications in paragraphs 5a through 5e of this AC and has demonstrated to the Administrator its ability to install this equipment on a representative number of similar type installations through prior field approvals. References to these previous approvals on FAA Form 337, Major Repair and Alteration (Airframe, Powerplant, Propeller or Appliance), constitute previously approved data and may not require a separate field approval.
- d. Alterations using ~~data~~ which do not differ appreciably from a previously approved alteration may not require new or additional approval. When questions arise, contact your local FAA field office for guidance.

7. TESTS AND INSPECTIONS.

a. Sections 91.411 and 91.413 require, in part, the performance of tests and inspection in accordance with methods, techniques, and practices of an inspection program acceptable to the Administrator. These tests and inspections may be performed only by persons possessing the requisite data and equipment to perform the required functions and meeting any of the following criteria:

- (1) The manufacturer of the airplane or helicopter.
- (2) A certificated repair station with—
 - (a) A Class I instrument rating,
 - (b) A Class III radio rating,
 - (c) A limited instrument or radio rating appropriate to the make and model of the appliance to be tested,
 - (d) A limited rating appropriate to the test to be performed,
 - (e) An airframe rating appropriate to the airplane or helicopter to be tested, or
 - (f) A limited rating for a manufacturer issued for the appliance to be tested.
- (3) A holder of a continuous airworthiness maintenance program as provided in 14 CFR part 121, part 129, or part 135.
- (4) An appropriately certificated and rated person under § 65.85.

b. Manufacturer's instructions for continued airworthiness are acceptable to the Administrator for use in testing and inspecting ATC transponders and altitude reporting equipment.

c. The following information sets forth one means, but not the only means, of demonstrating compliance with the maintenance requirements in § 91.413 governing the testing of ATC transponders.

(1) Reply Radio Frequency. Interrogate the transponder and verify, by use of any frequency measuring technique, that the reply frequency is 1090+3 MHz. The accuracy of the measuring device should be at least + or - .5 MHz. In the event the frequency measurement is not conducted by radiated method, necessary compensations should be made for any frequency deviation which may occur due to installation.

(2) Suppression. Interrogate the transponder with a Mode 3/A interrogation signal at a nominal repetition rate of 235 (nominal is considered to be 235 + or - 5 IPS) interrogations per second and at a signal level 3 db above receiver minimum trigger level. Adjust P2 pulse equal in amplitude to P1 pulse and verify that the reply rate is no greater than 3 replies per second. (Percentage of reply should not exceed 1.0 percent.) Adjust P2 pulse amplitude 9 db less than P1 pulse, and verify that the reply rate is at least 211 replies per second.

(3) Receiver Sensitivity. With the test set connected to the antenna end of the transmission line, or connected to the antenna terminal of the transponder with a correction for transmission line loss, interrogate the transponder with a Mode 3/A interrogation signal at any repetition rate recommended by the transponder manufacturer. When radiation techniques are used, the interrogation signal repetition rate should be a nominal 235 interrogations per second. This pulse repetition rate was selected to reduce interference to active aircraft in the air traffic control system. Adjust P1 and P3 equal in amplitude and apply a signal level known to be below receiver minimum trigger level (MTL). Increase the signal level until the transponder reply is 211 replies per second (90 percent reply rate). This is the receiver MTL. Verify the MTL is between 69 to 77 db below 1 milliwatt. Test equipment attenuator accuracy should be within + or -3 db. Repeat the test using a Mode C interrogation signal and verify the MTL is within 1 db of the reading obtained on Mode 3/A.

(4) Bench Tests. Transponders may be bench tested for compliance with § 91.413, and functionally checked after installation in the aircraft, provided that during the bench check the transponder operates into an antenna system presenting the same VSWR characteristics and cable attenuation as that in the airplane.

(5) Portable Line Test Equipment. Portable line test equipment may be used for any of the tests specified in paragraph 7c of this AC, provided it is maintained under a regular calibration program acceptable to the Administrator. If portable test equipment is used with appropriate coupling to the aircraft antenna system, an additional 3 db tolerance is permitted to compensate for antenna coupling errors during receiver sensitivity measurements. If the portable test equipment has a fixed radio frequency output, it may be necessary to use a fixed precision attenuator in conjunction with a variable precision attenuator to determine the receiver minimum triggering level. Such attenuators should be maintained on a regular calibration schedule and have appropriate calibration charts. The repair facility is responsible for ensuring the accuracy of the attenuators.

(6) Removal and Replacement. Removal and replacement of transponder units, during the 2-year period after testing in accordance with § 91.413, will not invalidate the test results. A repaired or replacement transponder may be installed without repeating the tests and inspections, provided the unit being installed has been tested by the agency for reply radio frequency, suppression, and receiver sensitivity in accordance with the manufacturer's instructions.

(7) Maintenance Records. Maintenance record entries should be made in accordance with § 43.9.

8. AN ACCEPTABLE MEANS OF TESTING FOR COMPLIANCE WITH § 91.217.

a. Section 91.217, Data correspondence between automatically reported pressure altitude data and the pilot's altitude reference, states, in part, that—

No person may operate any automatic pressure altitude reporting equipment associated with a radar beacon transponder—

Unless, as installed, that equipment was tested and calibrated to transmit altitude data corresponding within 125 feet (on a 95 percent probability basis) of the indicated or calibrated

datum of the altimeter normally used to maintain flight altitude, with that altimeter referenced to 29.92 inches of mercury.

b. The following simplified test of the automatic pressure altitude transmission system data correspondence, as required by § 91.217, can be used to demonstrate compliance of a newly installed altitude reporting system. Connect the transponder test set directly to the antenna terminal of the transponder, or to the antenna end of the transmission line, so as not to radiate an interfering signal.

(1) All aircraft that have altitude reporting transponders installed (Mode C capability) should be checked to ensure that only the framing pulses (F1 and F2) are transmitted in response to Mode C interrogations, when the altitude reporting feature is turned off.

(2) All transponder-equipped aircraft that have altitude reporting equipment installed should be tested at the flight levels set forth in appendix 1 (table 1 for encoding altimeters or table 2 for blind encoders), by alternately interrogating the transponder on Mode 3/A and Mode C and observing either the pulse train output, or the decoded altitude display on those test sets capable of decoding the pulse train.

(3) Set the altimeter normally used to maintain flight altitude to 29.92 inches of mercury (1013.2 millibars).

(4) Select the test points listed in table 1 or 2 (sea level) and the maximum operating altitude of the aircraft. Test each of these test points for increasing altitude and for decreasing altitude.

(5) Apply pressure to the static system, or directly to the altimeter. If separate static systems serve altimeters and digitizers, simultaneously apply identical pressure to each. Approach each test point slowly, decreasing pressure for increasing altitude, and vice versa, until a transition to the test point value occurs in the digital output. Record the pilot's altimeter reading at the instant of transition.

(6) Encoding digitizers, which are separate units (blind encoders) having their own individual pressure sensor, should be checked against the pilot's altimeter upon installation to ensure that the overall system accuracy of § 91.217 is met. It will be necessary to perform a check of the system accuracy any time either the encoder or altimeter is replaced. Matched components should be identified and the calibration information recorded.

(a) The matched set (blind encoder and altimeter) should be shop tested and calibrated at ambient temperature.

(b) This abbreviated environmental temperature test is only valid when both units are installed in the same environmental location (that is, both units mounted on instrument panel or in near vicinity of one another). Other installations require FAA engineering approval.

(7) In addition, where an installation allows for the blind encoder to be connected to a static source other than the static source connected to the altimeter normally used to maintain flight altitude, the following corrections should be applied during certification of compliance with § 91.217:

- (a) The difference between both static sources should be determined (in flight) and recorded. (This information may be available from the original aircraft certification data.)
- (b) The differences determined in paragraph 8(7)(a) (static source errors) should be used as a correction factor when checking for compliance with § 91.217.

9. TESTING PRECAUTIONS AND INSTALLATION RECOMMENDATIONS.

- a. Adequate precautions should be taken to avoid damage to any instruments connected to the aircraft pitot-static system, either by "TEE" connecting the pitot and static lines together, or by connecting the vacuum source directly to the altimeter and encoder when separate units are involved. The aircraft static system should be returned to ambient pressures before disconnecting pneumatic test equipment from aircraft/instruments. After completion of all testing, a leakage test of the static system should be performed if the static system has been opened.
- b. In aircraft equipped with plastic pitot or static lines, adequate precaution should be taken to avoid collapsing the plastic tubing at the higher differential pressures.
- c. The blind encoder or encoding altimeter should have an altitude encoding capability up to at least the service ceiling or maximum certificated altitude of the aircraft in which it is installed. If the altitude reporting system will not function throughout the aircraft operational envelope (up to the aircraft maximum operating altitude), a placard stating the aircraft altitude limitation should be installed.
- d. The barometric correlation adjustment should not be adjusted in the field; changing this adjustment will nullify the correspondence between the altimeter and its encoding digitizer or the associated blind encoder.
- e. Some altimeters may exhibit a tendency toward jerkiness (when not under vibration). If the jerkiness appears excessive, then the friction test should be conducted as described in AC 43-203B.
- f. Automatic altitude reporting system installations (either blind encoder or encoding altimeter types) may be shop tested for correspondence (using the transponder decoded output) and then functionally checked after installation in the aircraft, provided the same transponder encoding digitizer, altimeter and wiring harness, and coaxial cable are either installed in the aircraft or accurately compensated for.

APPENDIX 1 — TABLES

**TABLE 1. ALTITUDE INFORMATION PULSE POSITIONS
(Encoding Altimeters)**

Range (see appendix E to Part 43)	Pulse Position (0 to 1 in a pulse position denotes absence or presence of a pulse, respectively)											Correspondence Tolerance
Increments (feet)	D2	D4	A1	A2	A4	B1	B2	B4	C1	C2	C4	See appendix E to Part 43.
-50 to +50*	0	0	0	0	0	0	1	1	0	1	0	
950 to 1,050	0	0	0	0	0	1	1	0	0	1	0	
1,050 to 1,150	0	0	0	0	0	1	1	0	1	1	0	
1,250 to 1,350	0	0	0	0	0	1	1	1	1	0	0	
1,750 to 1,850	0	0	0	0	0	1	0	1	0	0	1	
2,550 to 2,650	0	0	0	0	0	1	0	0	0	1	1	
2,750 to 2,850	0	0	0	0	1	1	0	0	0	0	1	
6,750 to 6,850	0	0	0	1	1	0	0	0	0	0	1	
14,750 to 14,850*	0	0	1	1	0	0	0	0	0	0	1	
30,750 to 30,850**	0	1	1	0	0	0	0	0	0	0	1	

NOTES:

* Identifies transponder pulse positions and altitude limits necessary to check Class 1B and 2B transponders (equipment designed to operate at 15,000 feet and below). Reference TSO C-74c, Airborne ATC Transponder Equipment.

** Identifies transponder pulse positions and altitude limits necessary to check Class 1A and 2A transponders (equipment designed to operate above 15,000 feet). Reference TSO C-74c, Airborne ATC Transponder Equipment.

**TABLE 2. ALTITUDE INFORMATION PULSE POSITION
(Blind Encoders)**

Range	Pulse Position (0 to 1 in a pulse position denotes absence or presence of a pulse, respectively)											Altimeter Scale Error Tolerance	Correspondence Tolerance
	D2	D4	A1	A2	A4	B1	B2	B4	C1	C2	C4		
Increments (feet)													
-1,050 to -950	0	0	0	0	0	0	0	0	0	1	0	±20	See appendix E to Part 43.
-50 to +50	0	0	0	0	0	0	1	1	0	1	0	±20	
450 to 550	0	0	0	0	0	0	1	0	0	1	0	±20	
950 to 1,050	0	0	0	0	0	1	1	0	0	1	0	±20	
1,050 to 1,150	0	0	0	0	0	1	1	0	1	1	0	±20	
1,250 to 1,350	0	0	0	0	0	1	1	1	1	0	0	±23	
1,450 to 1,550	0	0	0	0	0	1	1	1	0	1	0	±25	
1,750 to 1,850	0	0	0	0	0	1	0	1	0	0	1	±27	
1,950 to 2,050	0	0	0	0	0	1	0	1	0	1	0	±30	
2,550 to 2,650	0	0	0	0	0	1	0	0	0	1	1	±30	
2,650 to 2,750	0	0	0	0	0	1	0	0	0	0	1	±30	
2,950 to 3,050	0	0	0	0	1	1	0	0	0	1	0	±30	
3,950 to 4,050	0	0	0	0	1	1	1	1	0	1	0	±35	
5,950 to 6,050	0	0	0	0	1	0	0	1	0	1	0	±40	
6,750 to 6,850	0	0	0	1	1	0	0	0	0	0	1	±48	
7,950 to 8,050	0	0	0	1	1	0	1	1	0	1	0	±60	
9,960 to 10,050	0	0	0	1	1	1	0	1	0	1	0	±80	
11,950 to 12,050	0	0	0	1	0	1	1	1	0	1	0	±90	
13,950 to 14,050	0	0	0	1	0	0	0	1	0	1	0	±100	
14,750 to 14,850	0	0	1	1	0	0	0	0	0	0	1	±104	
15,959 to 16,050	0	0	1	1	0	0	1	1	0	1	0	±110	
17,950 to 18,050	0	0	1	1	0	1	0	1	0	1	0	±120	
19,950 to 20,050	0	0	1	1	1	1	1	1	0	1	0	±130	
21,950 to 22,050	0	0	1	1	1	0	0	1	0	1	0	±140	
24,950 to 25,050	0	0	1	0	1	1	1	0	0	1	0	±155	
29,950 to 30,050	0	0	1	0	0	0	0	1	0	1	0	±180	
30,750 to 30,850	0	1	1	0	0	0	0	0	0	0	1	±184	
34,950 to 35,050	0	1	1	0	1	1	0	0	0	1	0	±205	
39,950 to 40,050	0	1	1	1	1	0	1	1	0	1	0	±230	
44,950 to 45,050	0	1	1	1	0	0	1	0	0	1	0	±255	
49,950 to 50,050	0	1	0	1	0	1	0	1	0	1	0	±280	

APPENDIX 2 — GLOSSARY OF TERMS

1. **Approved:** Unless used with reference to another person, this means approved by the Administrator.
2. **Blind Encoder (Digitizer):** An altitude reporting encoder that is pressure operated, having no altitude display; is not part of a pressure/altitude indicating device or system; does not contain an external means for barometric setting; and supplies the altitude reporting information to the ATC transponder.
3. **Data:** Any drawings, sketches, stress analysis, reports, operating limitations, or photographs that support or describe an alteration.
4. **Encoding Altimeter (Pressure Altitude):** An altitude indicator that displays to the pilot the pressure/altitude sensed by the device and produces an altitude-reporting digital code output.
5. **Indicated Datum of the Altimeter:** The altitude displayed by the altimeter when an ideal absolute pressure is applied to the sensing member of the altimeter. This altitude is not corrected for instrument error, nor for static source error.
6. **Calibrated Datum of the Altimeter:** The correction applied via a specific calibration card applicable to a specific altimeter to correct for instrument error (scale error) only.
7. **Correspondence:** The altimeter's displayed pressure/altitude (indicated or calibrated datum) compared to encoded altitude output from the blind encoder or encoding altimeter, for the entire period (from the moment the code output changes to a value to the moment the code output changes to the next value while the pressure/altitude is changing) that output code remains at the same digital information.
8. **Matched Components:** An altimeter and a blind encoder that have been tested and calibrated together and, as a combination, meet the requirements of § 91.217.

